NASA TECH BRIEF

Static Structural Analysis of Shell-Type Structures

A manual has been prepared that is, essentially, a condensation of material published by U.S. Government agencies, universities, and aerospace industries and in scientific and technical journals both domestic and foreign. The manual is arranged in 5 chapters.

Chapter 1.00 presents a derivation of general shell theory from concepts of the linear theory of elasticity and includes the basic relationships of shell geometry, geometry of strain, stress–strain, and equilibrium. The various shell theories are classified according to the simplifications made to a higher-order theory. Approximate theories and simplifications that have made the solution to these theories possible are delineated. A presentation of nonlinear shell theory to be used for large deflection analysis of shells is included. This development is based on variational principles and the concept of stationary potential energy. Structural stability shell theory is discussed. The shell stability equations are presented and techniques for determining buckling loads using variational procedures are outlined. A discussion of the discrepancies between the theoretical and experimental results is included.

In Chapter 2.00, instructions, procedures, basic solutions, and recommendations are presented to determine static deflections and internal load and stress distributions in shells under various loading conditions. This chapter also includes membrane solutions for various loading conditions, unit edge loading solutions, and combined solutions for various shell geometries and constructions, loadings, and boundary conditions. Factor-of-safety concepts, failure criteria, and margin-of-safety calculation under uniaxial and biaxial loading conditions are also presented.

Methods of analysis for the static instability (buckling) of shell structures are presented in Chapter 3.00. This chapter presents methods for obtaining the design allowable buckling loads for unstiffened cylinders, cones, spherical caps, and curved panels under various loading conditions. Also included are procedures for the stability analysis of orthotropic shells, stiffened cylinders, and sandwich shells. Analyses for inelastic buckling and combined loading conditions are also presented.

Chapter 4.00 presents methods of analysis to be used in preliminary design to determine the lightest shell wall for various constructions subjected to specific loading conditions. A survey of pertinent literature is also included in this chapter.

An introduction to the fundamentals of computer utilization is presented in Chapter 5.00. The basic computer characteristics are described. An introduction to matrix algebra is included in this chapter, in addition to a description of the techniques used in solving shell problems and discussions of the use of computers in conjunction with these techniques.

Note:

The "Shell Analysis Manual" is available as NASA CR-912 from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Patent status:

No patent action is contemplated by NASA.

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